

Patent claims

1. Kneadable and moldable bone-replacement material which consists of a mixture of
 - A) calcium-containing ceramic particles; and
 - B) a hydrogel or a substance which can be swelled into a hydrogel, and characterised by the fact that
 - C) the ceramic particles are of fully synthetic origin;
 - D) the individual ceramic particles have at least a partially cohesive, porous structure; and
 - E) the majority of the ceramic particles have a non-spheric shape.
2. Bone-replacement material in accordance with claim 1, characterised by the fact that the ceramic particles have an angular shape.
3. Bone-replacement material in accordance with claim 1 or 2, characterised by the fact that the ceramic particles have a sphericity relationship $S = D_{\max}/D_{\min}$ between the largest diameter D_{\max} and the smallest diameter D_{\min} which is larger than 1.2 and preferably larger than 1.5.
4. Bone-replacement material in accordance with claim 3, characterised by the fact that the sphericity relationship S is larger than 3 and preferably larger than 5.
5. Bone-replacement material in accordance with one of the claims 1 – 3, characterised by the fact that at least 50% and preferably at least 90% of the ceramic particles have a non-spheric shape.
6. Bone-replacement material in accordance with one of the claims 1 – 5, characterised by the fact that the pore size of the ceramic particles is between 1 and 500 micrometers.
7. Bone-replacement material in accordance with one of the claims 1 – 6, characterised by the fact that at least 50% of the ceramic particles have a pore size between 100 and 500 micrometers.
8. Bone-replacement material in accordance with claim 7, characterised by the fact that the pore size is between 1 and 100 micrometers.
9. Bone-replacement material in accordance with claim 8, characterised by the fact that the pore size is between 340 and 450 micrometers.
10. Bone-replacement material in accordance with one of the claims 1 – 9, characterised by the fact that the porosity of the ceramic particles is between 60 and 90 percent.
11. Bone-replacement material in accordance with one of the claims 1 – 10, characterised by the fact that the bulk density of the ceramic particles is between 0.2 g/ccm and 2.0 g/ccm.

12. Bone-replacement material in accordance with one of the claims 1 – 10, characterised by the fact that the bulk density of the ceramic particles is between 0.6 g/ccm and 1.0 g/ccm and preferably between 0.7 g/ccm and 0.9 g/ccm.
13. Bone-replacement material in accordance with one of the claims 1 – 10, characterised by the fact that the bulk density of the ceramic particles is between 1.0 g/ccm and 2.0 g/ccm and preferably between 0.2 g/ccm and 1.8 g/ccm.
14. Bone-replacement material in accordance with one of the claims 1 – 13, characterised by the fact that the jarring density of the ceramic particles is between 0.5 g/ccm and 2.5 g/ccm.
15. Bone-replacement material in accordance with claim 14, characterised by the fact that the jarring density of the ceramic particles is between 0.7 g/ccm and 1.1 g/ccm.
16. Bone-replacement material in accordance with claim 14, characterised by the fact that the jarring density of the ceramic particles is between 1.1 g/ccm and 2.5 g/ccm.
17. Bone-replacement material in accordance with one of the claims 1 – 16, characterised by the fact that the share of ceramic particles of non-spheric shape is at least 60% and preferably at least 80%.
18. Bone-replacement material in accordance with one of the claims 1 – 17, characterised by the fact that the average diameter of the ceramic particles is between 100 and 250 micrometers.
19. Bone-replacement material in accordance with one of the claims 1 – 17, characterised by the fact that the average diameter of the ceramic particles is between 250 and 500 micrometers.
20. Bone-replacement material in accordance with one of the claims 1 – 17, characterised by the fact that the average diameter of the ceramic particles is between 0.5 and 5.6 mm.
21. Bone-replacement material in accordance with one of the claims 18 – 20, characterised by the fact that ceramic particles with an average diameter of 100 to 250 micrometers are used together with those having an average diameter of 250 to 500 micrometers and/or together with those having an average diameter of 0.5 to 5.6 mm.
22. Bone-replacement material in accordance with one of the claims 1 – 21, characterised by the fact that the ceramic particles consist of a calcium-phosphate which is characterised by a molar Ca/P relationship between 1.0 and 2.0.
23. Bone-replacement material in accordance with claim 22, characterised by the fact that the ceramic particles consist of a calcium-phosphate which is characterised by a molar Ca/P relationship between 1.45 and 1.52.

24. Bone-replacement material in accordance with claim 22, characterised by the fact that the ceramic particles consist of a calcium-phosphate which is characterised by a molar Ca/P relationship between 1.45 and 1.49.
25. Bone-replacement material in accordance with one of the claims 22- 24, characterised by the fact that the calcium phosphate is selected from the following group: Dicalcium-phosphate-dihydrate ($\text{CaHPO}_4 \times 2 \text{H}_2\text{O}$), dicalcium-phosphate (CaHPO_4), alpha-tricalcium-phosphate ($\alpha\text{-Ca}_3(\text{PO}_4)_2$), beta-tricalcium-phosphate ($\beta\text{-Ca}_3(\text{PO}_4)_2$), calcium-deficient hydro-xyapatite ($\text{Ca}_9(\text{PO}_4)_5(\text{HPO}_4)\text{OH}$), hydro-xyapatite ($\text{Ca}_{10}(\text{PO}_4)_6\text{OH}_2$), carbonated apatite ($\text{Ca}_{10}(\text{PO}_4)_3(\text{CO}_3)_3(\text{OH})_2$), fluoride-apatite ($\text{Ca}_{10}(\text{PO}_4)_6(\text{F},\text{OH})_2$), chloride-apatite ($\text{Ca}_{10}(\text{PO}_4)_6(\text{Cl},\text{OH})_2$), whitlockite ($((\text{Ca},\text{Mg})_3(\text{PO}_4)_2)$), tetracalcium-phosphate ($\text{Ca}_4(\text{PO}_4)_2\text{O}$), oxyapatite ($\text{Ca}_{10}(\text{PO}_4)_6\text{O}$), beta-calcium-pyrophosphate ($\beta\text{-Ca}_2(\text{P}_2\text{O}_7)$), alpha-calcium-pyrophosphate, gamma-calcium-pyrophosphate, octo-calcium-phosphate ($\text{Ca}_8\text{H}_2(\text{PO}_4)_6 \times 5 \text{H}_2\text{O}$).
26. Bone-replacement material in accordance with one of the claims 1 – 25, characterised by the fact that the ceramic particles consist of a mixture of different calcium-phosphates.
27. Bone-replacement material in accordance with one of the claims 1 – 21, characterised by the fact that the ceramic particles consist of a calcium-sulfate.
28. Bone-replacement material in accordance with one of the claims 1 – 21, characterised by the fact that the ceramic particles consist of a calcium-carbonate.
29. Bone-replacement material in accordance with one of the claims 1 – 21, characterised by the fact that the ceramic particles are selected from the following group: alpha-calcium-sulfate-hemihydrate, beta-calcium-sulfate-hemihydrate, calcium-sulfate-dihydrate.
30. Bone-replacement material in accordance with one of the claims 1 – 21, characterised by the fact that the ceramic particles consist of a mixture of different calcium-phosphates, calcium-sulfates and/or calcium-carbonates.
31. Bone-replacement material in accordance with one of the claims 1 – 21, characterised by the fact that it contains metallic or semi-metallic ion shares as additives.
32. Bone-replacement material in accordance with one of the claims 1 – 31, characterised by the fact that the hydrogel or the substance which can be swelled into a hydrogel consists of fully synthetic substances.
33. Bone-replacement material in accordance with one of the claims 1 – 31, characterised by the fact that the hydrogel or the substance which can be swelled into a hydrogel consists of natural biological substances, preferably of plant origin.
34. Bone-replacement material in accordance with one of the claims 1 – 31, characterised by the fact that the hydrogel or the substance which can be swelled into a hydrogel consists of a biotechnologically generated substance.

35. Bone-replacement material in accordance with one of the claims 32 – 34, characterised by the fact that the hydrogel or the substance which can be swelled into a hydrogel consists of a mixture of fully synthetic, natural biological or biotechnologically generated substances.
36. Bone-replacement material in accordance with one of the claims 1 – 35, characterised by the fact that the hydrogel or the substance which can be swelled into a hydrogel contains one of the following components: a) polyamino-acids or their derivatives, preferably polylysine or gelatin; b) polysaccharides and their derivatives, preferably glycosaminoglycane or alginate; c) polylipides, fatty acids and their derivatives; d) nucleotides and their derivatives; or a combination of the components as listed in a) through d).
37. Bone-replacement material in accordance with one of the claims 1 – 35, characterised by the fact that the hydrogel or the substance which can be swelled into a hydrogel contains one of the following components: a) polymethylenoxide or its derivatives; b) polyethylene, polyethylenoxide or their derivatives; c) polypropylene, polypropylenoxide or their derivatives; d) polyacrylate or its derivatives; or a combination of the components as listed in a) through d).
38. Bone-replacement material in accordance with one of the claims 1 – 37, characterised by the fact that the hydrogel or the substance which can be swelled into a hydrogel consists of either a glycosaminoglycane or a proteoglycane or a mixture of those two substances.
39. Bone-replacement material in accordance with claim 38, characterised by the fact that the glycosaminoglycane is a hyaluron-acid, chondroitinsulfate, dermatansulfate, heparansulfate, heparine or keratansulfate.
40. Bone-replacement material in accordance with one of the claims 1 – 39, characterised by the fact that the concentration of the ready-to-use, hydrated hydrogel or the ready-to-use, hydrated substance which can be swollen into a hydrogel is between 0.1% and 20.0%.
41. Bone-replacement material in accordance with one of the claims 1 – 40, characterised by the fact that the molecular weight of the hydrogel or the substance which can be swelled into a hydrogel is larger than 300'000 Dalton and preferably larger than 500'000 Dalton.
42. Bone-replacement material in accordance with claim 41, characterised by the fact that the molecular weight of the hydrogel or the substance which can be swelled into a hydrogel is larger than 1'000'000 Dalton and preferably larger than 1'500'000 Dalton.
43. Bone-replacement material in accordance with one of the claims 1 – 42, characterised by the fact that the hydrogel is a liquid solution of a hyaluronate.
44. Bone-replacement material in accordance with claim 43, characterised by the fact that the liquid solution of the hydrogel contains less than 99% water and preferably less than 98% water.

45. Bone-replacement material in accordance with claim 43, characterised by the fact that the liquid solution of the hydrogel contains less than 96.5% water and preferably less than 95% water.
46. Bone-replacement material in accordance with one of the claims 43 – 45, characterised by the fact that the molecular weight of the hyaluron-acid used is larger than 1.5×10^6 Dalton.
47. Bone-replacement material in accordance with one of the claims 43 – 45, characterised by the fact that the molecular weight of the hyaluron-acid used is between 0.5×10^6 and 1.0×10^6 Dalton.
48. Bone-replacement material in accordance with one of the claims 43 – 45, characterised by the fact that the molecular weight of the hyaluron-acid used is smaller than 1×10^6 and preferably smaller than 0.5×10^6 Dalton.
49. Bone-replacement material in accordance with one of the claims 1 – 48, characterised by the fact that the specific gravity of the calcium-containing, porous ceramic particles is between 0.5 and 1.0 g/ccm.
50. Bone-replacement material in accordance with one of the claims 1 – 49, characterised by the fact that the weight relationship A/B between the hydrated hydrogel and the calcium-containing ceramic particles is larger than 0.2.
51. Bone-replacement material in accordance with claim 50, characterised by the fact that the weight relationship A/B is between 0.2 and 0.5.
52. Bone-replacement material in accordance with claim 50, characterised by the fact that the weight relationship A/B is between 0.5 and 0.9.
53. Bone-replacement material in accordance with claim 50, characterised by the fact that the weight relationship A/B is between 0.9 and 1.3.
54. Bone-replacement material in accordance with claim 50, characterised by the fact that the weight relationship A/B is between 1.3 and 2.0.
55. Bone-replacement material in accordance with claim 50, characterised by the fact that the weight relationship A/B is between 2 and 5.
56. Bone-replacement material in accordance with claim 50, characterised by the fact that the weight relationship A/B is larger than 5.